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BAKER (MICHAEL) JR INC BEAVER PA

NATIONAL DAM SAFETY PROGRAM. WARRENTON LAKE DAM (INVENTORY NUMB--ETC(U)

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11. ABSTRACT

12. ABSTRACT (continued)

13. PERFORMING ORGANIZATION NAME AND ADDRESS

14. DISTRIBUTION STATEMENT

15. AUTHOR

16. PERFORMING ORGANIZATION NAME AND ADDRESS

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26. ABSTRACT

27. PERFORMING ORGANIZATION NAME AND ADDRESS

28. DISTRIBUTION STATEMENT (The above statement is derived from DTIC Report)

29. SUPPLEMENTARY NOTES

30. SUPPLEMENTARY NOTES (continued)

31. SUPPLEMENTARY NOTES

32. KEY WORDS (Continue on reverse side if necessary and identify by block number)

33. DAMS

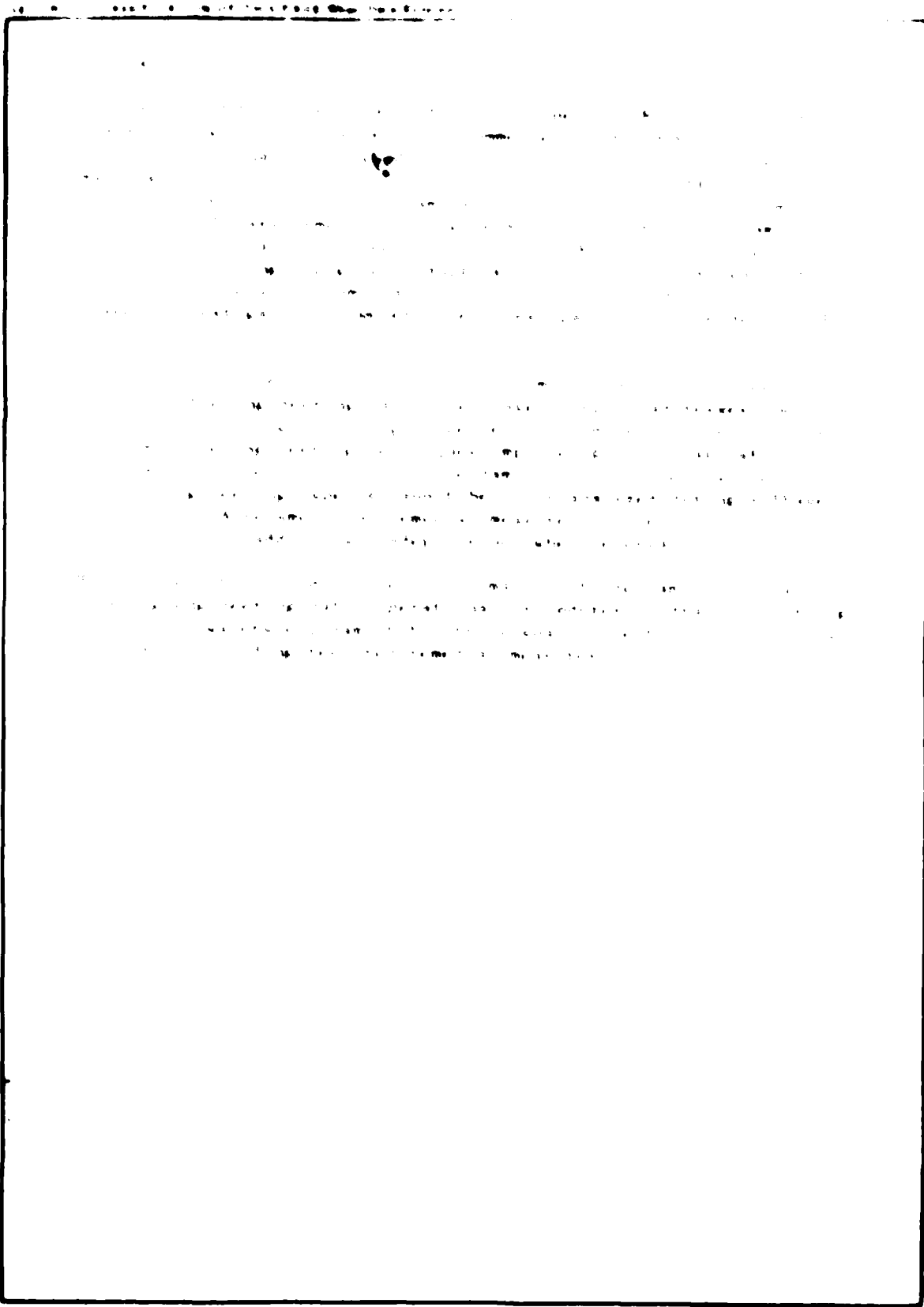
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36. DAM INSPECTION

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## PREFACE

This report is prepared to help state officials in the Reclamation Service to safely inspect dams for Phase I investigations. Copies of these guidelines may be obtained from the office of the Chief of Engineers, Washington, D. C. The purpose of a Phase I investigation is to identify existing dams which may present a hazard to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspection. Detailed investigation and analyses, including mapping and scientific investigation, are not required. Computerized evaluations are beyond the scope of a Phase I investigation. Where the investigation is sufficient to identify any need for additional work.

It is essential to report on these dams as realized that the reported condition of the dam is based on observations of the dam and its appurtenances at the time of inspection, along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action will compromise the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (flood discharges that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the design flood should not be interpreted as necessarily posing a highly inadequate condition. The design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition, and the downstream damage potential.

PHASE I INSPECTION REPORT  
NATIONAL DAM SAFETY PROGRAM

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NAME OF DAM: WARRENTON LAKE DAM

PHASE I INSPECTION REPORT  
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Name of Dam: Warrenton Lake Dam  
State: Commonwealth of Virginia  
County: Fauquier  
USGS 7.5 Minute Quadrangles: Warrenton, Virginia and  
Marshall, Virginia  
Stream: Unnamed Tributary to Cedar Creek  
Date of Inspection: 20 May 1981

BRIEF ASSESSMENT OF DAM

Warrenton Lake Dam is an earthfill embankment approximately 24.9 feet high<sup>1</sup> and 369 feet long. The principal spillway is a 48-inch diameter concrete drop inlet riser located near the center of the dam. An open channel emergency spillway is located on the left abutment. The dam, located about 1.5 miles northeast of Warrenton, Virginia, is used for recreation. The dam is owned by Melvin Helinick, Forest Road, RFD 4, Warrenton, Virginia 22186. Warrenton Lake Dam is a "small" size - "significant" hazard structure as defined by the Recommended Guidelines for Safety Inspection of Dams. The dam and appurtenant structures were in fair overall condition at the time of inspection. Maintenance of the dam is considered to be inadequate.

There is a slope failure on the downstream face of the dam midway up the slope. This failure extends the length of the embankment. Because the embankment slopes are steeper than those recommended in the Bureau of Reclamation's guidelines for small dams and because of the slope failure observed, a stability check of the dam is required.

Using the Corps of Engineers' screening criteria for initial review of spillway adequacy, the 100-year flood was selected as the spillway design flood (SDF). The spillway is capable of passing 100 percent of the SDF or 39 percent of the Probable Maximum Flood (PMF) without overtopping the dam. The spillway is adjudged as adequate.

Due to the embankment stability problems observed, the dam is assessed as unsafe, non-emergency.

<sup>1</sup>Measured from the streambed at the downstream toe to the embankment crest.

NAME OF DAM: WARRENTON LAKE DAM

It is recommended that, within two months of the date of notification of the Governor of the Commonwealth of Virginia, a qualified geotechnical engineering firm should be retained by the owner to perform a stability check of the dam and to further evaluate the wet area to the right of the principal spillway.

Within six months of the notification of the Governor, the consultant's report of appropriate remedial measures should have been completed and the owner should have an agreement with the Commonwealth of Virginia for a reasonable time frame in which all remedial measures will be completed.

Visual inspection and office analyses indicate deficiencies requiring remedial treatment.

Regular inspections should be made of the dam and appurtenant structures. A thorough check list should be compiled for use by the owner's representative as a guide for the inspections. Maintenance items should be completed annually.

A flood warning system and emergency action plan should be promptly developed and put into operation. It is recommended that a formal emergency procedure be prepared, prominently displayed, and furnished to all operating personnel. This should include:

- 1) How to operate the dam in an emergency.
- 2) Who to notify, including public officials, in case evacuation from the downstream area is necessary.
- 3) Procedures to evaluate inflow during periods of emergency operation.

The following repair items should be accomplished as part of the general maintenance of the dam:

- 1) Remove all trees and brush growing on the embankment by cutting them off at ground level. Trees with a trunk diameter of greater than 3 inches should also have their root systems removed and the resultant holes backfilled, compacted, regraded and seeded.
- 2) Backfill, compact, and seed the depression on the crest and all areas of erosion.
- 3) Remove the debris lodged in the principal spillway riser and install a trash rack.

NAME OF DAM: WARRENTON LAKE DAM



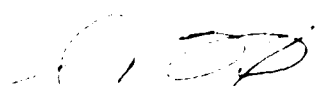
- 4) Repair the leak in the principal spillway and monitor for future leakage.
- 5) Extend the outlet pipe, fill, compact, and seed the eroded area. The length to which the pipe and embankment must be extended should be determined as part of the stability analysis of the dam. Provide erosion protection for the channel downstream from the outlet pipe.
- 6) Provide erosion protection for the upstream face of the embankment.
- 7) Clear the downstream channel of debris, trees, and brush.
- 8) Install a staff gage to monitor reservoir levels above normal pool.

MICHAEL BAKER, JR., INC.

SUBMITTED:

Original signed by:  
Carl S. Anderson, Jr.

Carl S. Anderson, Jr., P.E.  
Acting Chief, Design Branch

  
- Michael Baker, III, P.E.  
Chairman of the Board and  
Chief Executive Officer

RECOMMENDED:

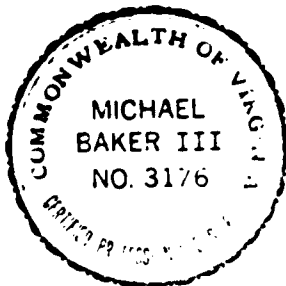
Original signed by  
JAMES A. WALSH

for Jack G. Starr, P.E.  
Chief, Engineering

APPROVED:

Original signed by:  
Ronald E. Hudson

Ronald E. Hudson  
Colonel, Corps of Engineers  
District Engineer



Date:

SEP 11 1981

NAME OF DAM: WARRENTON LAKE DAM



OVERALL VIEW OF DAM

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PHASE I INSPECTION REPORT  
NATIONAL DAM SAFETY PROGRAM  
NAME OF DAM: WARRENTON LAKE DAM ID# VA 06134

SECTION 1 PROJECT INFORMATION

1.1 General

1.1.1 Authority: Public Law 92-367, 8 August 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a national program of safety inspections of dams throughout the United States. The Norfolk District has been assigned the responsibility of supervising the inspection of dams in the Commonwealth of Virginia.

1.1.2 Purpose of Inspection: The purpose is to conduct a Phase I inspection according to the Recommended Guidelines for Safety Inspection of Dams (Reference 12, Appendix IV). The main responsibility is to expeditiously identify those dams which may be a potential hazard to human life or property.

1.2 Description of Project

1.2.1 Description of Dam and Appurtenances: Warrenton Lake Dam is an earthfill embankment approximately 24.9 feet high<sup>1</sup> and 369 feet long. The crest of the dam is about 16.4 feet wide and the minimum elevation of the crest is 1005.9 feet Temporary Bench Mark (T.B.M.)<sup>2</sup>. The slope of the upstream face of the embankment is approximately 2.9H:1V (Horizontal to Vertical) and the slope of the downstream face of the embankment is 2.6H:1V. The slope of the downstream face increases to 1.3H:1V in the area above and around the outlet pipe. There is no information available on any possible zoning of the

<sup>1</sup>Measured from the streambed at the downstream toe to the embankment crest.

<sup>2</sup>All elevations are referenced to a Temporary Bench Mark located on top of the concrete intake riser. The assumed elevation is 1000.0 feet.

NAME OF DAM: WARRENTON LAKE DAM

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embankment. No evidence of an internal drainage system for the dam was found. There is no slope protection on the embankment.

The principal spillway is a 48-inch diameter concrete riser. It is located near the center of the dam and has a crest elevation of 1000.0 feet T.B.M. Water passing into the intake riser is transmitted through an 18-inch diameter concrete pipe that extends through the embankment. The pipe discharges into the natural stream channel.

The emergency spillway is a trapezoidal shaped grass lined channel located on the left abutment with a crest elevation of 1001.6 feet T.B.M. and a bottom width of 11 feet. The discharge channel follows the left abutment slope and enters the downstream channel after passing through a wooded area for a short distance.

The reservoir has a drainage area of 1.14 square miles. The watershed consists primarily of grassland. The area around Warrenton Lake Dam is a newly built residential development.

- 1.2.2 Location. Warrenton Lake Dam is located in Fauquier County, Virginia on an isolated tributary to Cedar Run approximately 1.5 miles northeast of Warrenton, Virginia. A location plan is included with this report in Appendix I.
- 1.2.3 Size Classification. The height of the dam is 14.9 feet and the reservoir storage capacity at the crest of the dam (elevation 1005.9 feet T.B.M.) is 11.4 acre-feet. The dam is in the "small" size category as defined by the Recommended Guidelines for Safety Inspections of Dams.
- 1.2.4 Hazard Classification. The road into the home development crosses the streambed channel 500 feet downstream and a second road is located 1400 feet downstream of Warrenton Lake Dam. Several homes are located in the floodplain of the stream just above the spillway.

NAME: F. LAY      ADDRESS: N. LAY, LAY

of a dam failure is not considered highly probable; however, economic losses due to damage to the road, homes, and downstream dam are likely in the event of a dam failure. Warrenton Lake Dam is considered to be in the "significant" hazard category as defined by the Recommended Guidelines for Safety Inspection of Dams. The hazard classification used to categorize dams is a function of location only and is not related to stability or probability of failure.

- 1.2.5 Ownership: The dam and reservoir are owned by Melvin Helinick, Forest Road, RFD 4, Warrenton, Virginia 22186.
- 1.2.6 Purpose of Dam: The reservoir is used for recreational purposes.
- 1.2.7 Design and Construction History: A member of the homeowners' association reported that a gully was cut in the emergency spillway about 10 feet below the crest of the dam during a storm which occurred around 1976. A sewerline was placed in the emergency spillway at a depth of about 5 feet when this gully was repaired one year later. No other information on the design or construction history was available for use in this report.
- 1.2.8 Normal Operating Procedure: The reservoir level is maintained automatically by the crest of the principal spillway (elevation 1000.0 feet T.B.M.). No formal operating procedures are followed for this structure.

### 1.3 Pertinent Data

- 1.3.1 Drainage Area: The total drainage area tributary to Warrenton Lake Dam is 0.59 square miles.
- 1.3.2 Discharge at Dam Site: The maximum discharge from the reservoir is unknown.

Pool level at minimum top of dam:

Principal Spillway	28.0 c.f.s.
Emergency Spillway	1880.0 c.f.s.

NAME OF DAM: WARRENTON LAKE DAM

1.3.3 Dam and Reservoir Data: Pertinent data on the dam and reservoir are provided in the following table:

TABLE 1.1 DAM AND RESERVOIR DATA

Item	Elevation (feet T.B.M.)	Area (acres)	Reservoir Capacity		Length (feet)
			Acre- feet	Watershed (inches)	
Top of dam	1005.9	14.2	112 0	3 0	112
Emergency spillway	1001.6	10.3	67 5	1 1	14
Principal spillway crest	1000.0	8.8	46 0	1 5	114
Streambed at toe	981.0	-	-	-	-

NAME OF DAM: WARRENTON LAKE DAM

NAME	F. DAY	PRESENT	N. DATE	F. DAY
...	...	...	...	...

1. *Journal of the American Medical Association*, 1990; 263: 1025-1026.

[illegible]

of the embankment will tend to be in fair condition. The upstream face of the embankment is covered with small trees and brush with a diameter of 4" and above normal pool level. Erosion of the face is occurring because these trees, resulting in a vertical drop on the face of 2-3.5 feet. Severe erosion is also occurring on the downstream face of the embankment at and above the outlet pipe. It appears that the slope of the embankment around the outlet pipe was increased by raising the bottom width of the embankment to allow for a shorter length of pipe into the embankment. It is in this deeper portion of the embankment where the severe erosion is taking place. There is a small depression on the downstream edge of the embankment crest. An erosion gully has developed at the junction of the upstream edge of the embankment crest and the emergency spillway. A wet area was observed along the toe of the dam to the right of the outlet pipe. There was no measurable flow from the area. No evidence of an internal drainage system was found during the inspection.

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Visual signs of instability were noted along the downstream slope. Sloughing and signs of slope failure with a 1 foot scarp exist along the length of this slope midway up the embankment.

3.1.3

Appurtenant Structures: The principal spillway (as described in Section 1.2.1) was found to be in fair condition. The intake consists of a 48-inch diameter concrete riser pipe. There is no trash rack protecting the pipe, and debris was observed in the bottom of the pipe. There also appears to be a leak in the lower section of the riser.

The outlet pipe is an 18-inch diameter concrete pipe. As discussed in Section 3.1.2, the pipe is not long enough. The outlet channel is a natural channel. There is debris in the channel approximately 10 feet downstream from the outlet pipe. This debris has blocked the channel outlet, forming a pool which backs up to the outlet pipe. The reservoir slopes gently up to the entrance of the emergency spillway. The spillway is a trapezoidal earth channel. There is a good cover of grass in the channel. The discharge channel is a trapezoidal earth channel consisting of rocky soil with a sparse cover of grass. Residents near the dam indicated that, during a storm approximately 5 years ago, the emergency spillway was activated. A gully was cut in the channel approximately 5 feet deep. A sewer line was reportedly laid in this when it was repaired 1 year later. The channel is infringed upon by wooden fences surrounding the residents' property on the left abutment. A dike with its crest 4-5 feet below the top of dam forms the left side of the channel. The channel becomes very steep beyond the embankment. There is a home approximately 150 feet downstream from the dike which will be effected if flows in the spillway cause the dike to fail.

3.1.4

Reservoir Area: The slopes of the reservoir are moderate to mild with no signs of erosion or instability. They were grass covered with a number of residences surrounding the reservoir.

NAME OF DAM: WARRENTON LAKE DAM

Sedimentation does not appear to be a problem. Soundings were taken, and the depth of the normal pool was measured to be 13.4 feet near the riser pipe. No significant accumulations of debris were observed in the reservoir area.

3.1.5 Downstream Channel: A road into the housing development crosses the downstream channel 560 feet downstream, and another dam is 1900 feet downstream from the dam. The channel has moderate slopes. Two homes are located in the flood plain between the road and the downstream dam.

3.1.6 Instrumentation: There was no instrumentation present at the dam.

3.2 Evaluation: In general, the dam and appurtenant structures were found to be in fair condition. The slope failure on the downstream face should be investigated and repaired. The erosion of the upstream face is not considered to be a serious problem at this time. However, the trees and brush should be removed and another means of erosion protection provided. The depression on the downstream edge of the embankment crest should be filled in. The erosion gully at the junction of the upstream edge of the embankment crest and the emergency spillway should be filled, compacted, and reseeded. The wet area along the toe of the dam to the right of the outlet pipe is probably the result of poor surface drainage. The area should be regraded to improve surface drainage and monitored for seepage.

The debris should be removed from the intake pipe and a trash rack installed. The leak in the pipe should be sealed. The outlet pipe should be extended. The debris should be removed from the outlet channel and the channel graded to improve flow out of the channel. The fences infringing on the spillway channel should be removed. Because of the steepness of the channel, erosion may be a problem if the spillway is activated. Erosion protection should be provided in the downstream sections of the emergency spillway channel, especially along the dike.

A staff gage should be installed to monitor reservoir levels above normal pool.

NAME OF DAM: WARRENTON LAKE DAM

#### SECTION 4 - OPERATIONAL PROCEDURES

- 4.1 Procedures: Operation of the dam is an automatic function controlled by the principal spillway and the emergency spillway. Water entering the reservoir flows into the principal spillway at elevation 1000.0 feet T.B.M. When inflow is sufficient to cause the reservoir level to rise above elevation 1001.6 feet T.B.M., discharge takes place through the emergency spillway on the left abutment.
- 4.2 Maintenance of Dam: Maintenance of the dam is the responsibility of the owner. An inspection or maintenance schedule has not been instituted.
- 4.3 Maintenance of Operating Facilities: None were observed at the time of the inspection.
- 4.4 Warning System: At the time of inspection, there was no warning system or emergency action plan in operation.
- 4.5 Evaluation: Maintenance of the dam in the past has been inadequate. Regular inspections of the dam and appurtenant structures should be made and documented. A thorough check list should be compiled for use by the owner's representative as a guide for the inspections. Maintenance items should be corrected annually. A warning system and emergency action plan should be developed and implemented as soon as possible. This plan should include:
- a. How to operate the dam during an emergency.
  - b. Who to notify, including public officials, in case evacuation from the downstream area becomes necessary.

The local Emergency Services Coordinator of the State Office of Energy and Emergency Services can assist in the preparation of an emergency warning plan.

NAME OF DAM: WARRENTON LAKE DAM

## SECTION 5 - HYDRAULIC/HYDROLOGIC DATA

- 5.1 Design: No design data were available for use in preparing this report.
- 5.2 Hydrologic Information: No rainfall, stream gage or reservoir stage records are maintained for this dam.
- 5.3 Flood Experience: No records were available. As described in Section 3, a deep gully was cut in the emergency spillway during a storm which occurred around 1976.
- 5.4 Flood Potential: The Probable Maximum Flood (PMF), 1/2 Probable Maximum Flood (1/2 PMF), and 100-year flood were developed and routed through the reservoir by use of the HEC-1 DB computer program (Reference 9, Appendix IV) and appropriate unit hydrograph, precipitation and storage-outflow data. Clark's  $T_c$  and R coefficients for the local drainage areas were estimated from basin characteristics. The rainfall applied to the unit hydrograph was taken from publications by the U.S. Weather Bureau and the National Oceanic and Atmospheric Administration (References 16 and 17, Appendix IV). Rainfall losses for the PMF were estimated at an initial loss of 1.0 inches and a constant loss rate of 0.05 inches per hour thereafter. Rainfall losses for the 100-year flood were estimated at an initial loss of 1.5 inches and a constant loss rate of 0.15 inches per hour thereafter.
- 5.5 Reservoir Regulation: Pertinent dam and reservoir data are provided in Table 1.1, Paragraph 1.3.3.

Regulation of flow from the reservoir is primarily automatic. Normal flows are maintained by the crest of the principal spillway at elevation 1000.0 feet T.B.M. Water may also discharge through the emergency spillway on the left abutment when the reservoir rises above an elevation of 1001.6 feet T.B.M.

Outlet discharge capacity was computed by hand. Reservoir area was estimated from the Warrenton, Virginia and Marshall, Virginia, 7.5 minute USGS quadrangles, and storage capacity curves above normal pools were computed by the HEC-1 DB program. All flood routings were begun with the reservoir at normal pool. Flow through the principal spillway was included in the routings.

NAME OF DAM: WARRENTON LAKE DAM

- 5.6 Overtopping Potential: The probable rise of the reservoir and other pertinent information on reservoir performance are shown in the following table:

TABLE 5.1 RESERVOIR PERFORMANCE

Item	Normal <sup>1</sup>	Hydrographs		
		100-Year	1/2 PMF	PMF <sup>2</sup>
Peak flow, c.f.s.				
Inflow	1.0	1404.0	3553.0	7106.0
Outflow	1.0	1115.0	3255.0	7025.0
Peak elev., ft. T.B.M.	1000.0	1004.6	1006.7	1007.9
Non-overflow section (elev. 1005.9 ft. T.B.M.)				
Depth of flow, ft.	-	0.0	0.8	2.01
Average velocity, f.p.s. <sup>3</sup>	-	0.0	4.1	6.6
Total duration of over- topping, hrs.	-	0.0	0.6	1.17
Tailwater elev., ft. T.B.M.	983.1	-	-	-

<sup>1</sup>Conditions at time of inspection.

<sup>2</sup>The PMF is an estimate of flood discharges that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in a region.

<sup>3</sup>Velocity estimates were based on critical depth at control section.

- 5.7 Reservoir Emptying Potential: No facilities for drawing down the reservoir were observed at the time of the inspection.

- 5.8 Evaluation: Warrenton Lake Dam is a "small" size - "significant" hazard dam requiring evaluation for a spillway design flood (SDF) in the range between the 100-year flood and the 1/2 PMF. Due to the risk involved, the 100-year flood was selected as the SDF. The 100-year flood was routed through the reservoir and found that the spillways will pass the SDF without overtopping the dam. The spillways are capable of passing up to 38 percent of the PMF or 100 percent of the SDF without overtopping the dam.

Conclusions pertain to present day conditions and the effect of future development on the hydrology has not been considered.

NAME OF DAM: WARRENTON LAKE DAM

## SECTION 6 - STABILITY ANALYSIS

- 6.1 Foundation and Abutments: No information is available on the foundation conditions other than observations made at the time of the inspection. The Geologic Map of Virginia shows the dam is located within the Blue Ridge Province. This particular location is characterized by Metamorphosed Sedimentary Rock of uncertain age. Soil samples taken from the area were found to be dark brown sandy silt with a trace of clay.

No evidence of substantial seepage was observed during the inspection or any problems associated with piping of the foundation or abutment materials. Based on the visual inspection of the dam, it is believed no internal drainage system for the dam exists. Information on the keying of the dam into the foundation was unavailable.

### 6.2 Embankment

- 6.2.1 Materials: There was no information describing the nature of the materials or any zoning within the embankment. The outer embankment was found to be clayey silt of low plasticity.

- 6.2.2 Stability: Design Plans and previous stability analysis results were unavailable for this inspection. The dam is 24.9 feet high with a crest width of 16.4 feet. The upstream slope was measured to be 2.9H:1V. The downstream slope varies between 2.6H:1V and 1.3H:1V and is inconsistent throughout the downstream face. The discontinuity exists around the discharge pipe (see Field Sketch) where the slope is 1.3H:1V. The outlet facilities did not provide the capability to drain the reservoir in the event of an emergency. Therefore, the embankment is not considered susceptible to rapid drawdown.

According to the guidelines presented in Design of Small Dams by the U.S. Department of the Interior, Bureau of Reclamation for small dams of the described material with stable foundations not subject to rapid drawdown, the recommended slopes are 3H:1V for the upstream face and 2.5H:1V for the

NAME OF DAM: WARRENTON LAKE DAM

downstream slope. The recommended crest width is 14.5 feet. The crest width is within these guidelines, while the upstream slope and portions of the downstream slope are inadequate.

Visual signs of instability were noted along the downstream slope. Sloughing and signs of slope failure existed along the length of this slope midway up the embankment with a 1 foot scarp. Erosion is occurring all around the downstream end of the outlet pipe making the inadequate slope within this area even more unsafe. Depressions were also found along the downstream edge of the crest. These depressions are probably ruts created by vehicles driving over the dam.

Operating records were unavailable for this inspection. A nearby resident of Warrenton Lake, reported that approximately 5 years ago (1976), a deep gully was washed out in the emergency spillway. The wash out zone extended to a depth of 10 feet below the crest of the dam. One year later, the emergency spillway was repaired. A sewerline was placed within the emergency spillway area at the time of the repairs approximately 5 feet below the present surface.

- 6.3 Evaluation: The results of a previous stability analysis were unavailable for review as a part of this evaluation. Other visual signs of instability were noted as previously mentioned in Section 6.2.2. The present conditions of the aforementioned problems indicate that a stability check of the dam should be performed by a geotechnical engineer. This analysis should include consideration of the slope failure on the downstream face of the embankment and the excessively steep embankment section at the outlet pipe. Measures for repairing these problems and extending the present outlet pipe should be prepared.

NAME OF DAM: WARRENTON LAKE DAM

## SECTION 7 - ASSESSMENT REMEDIAL MEASURES

- 7.1 Dam Assessment: There is insufficient information to evaluate foundation conditions and embankment stability. There were no engineering data available for use in preparing this report. Deficiencies discovered during the field inspection and office analyses require remedial treatment. The dam and appurtenant structures are generally in fair overall condition. Maintenance of the dam is considered inadequate.

The area of slope failure along the downstream face of the dam, and the steep embankment slopes indicate that a detailed stability analysis should be performed.

Using the Corps of Engineers' screening criteria for initial review of spillway adequacy, the 100-year flood was selected as the SDF for the "small" size - "significant" hazard classification of Warrenton Lake Dam. The spillways are capable of passing up to 100 percent of the SDF or 38 percent of the PMF without overtopping the dam. Therefore, the spillway is adjudged adequate.

Due to the embankment stability problems observed, the dam is assessed as unsafe non-emergency.

There is no warning system or emergency action plan currently in operation.

- 7.2 Recommended Remedial Measures: It is recommended that within two months of the date of notification of the Governor of the Commonwealth of Virginia, a qualified geotechnical engineering firm should be retained by the owner to perform a stability check of the dam and to further evaluate the wet area to the right of the principal spillway.

Within six months of the notification of the Governor, the consultant's report of appropriate remedial measures should have been completed and the owner should have an agreement with the Commonwealth of Virginia for a reasonable time frame in which all remedial measures will be complete.

Regular inspections should be made of the dam and appurtenant structures. A thorough check list should be compiled for use by the owner's representative as a guide for the inspections. Maintenance items should be completed annually.

NAME OF DAM: WARRENTON LAKE DAM



A formal warning system and emergency action plan should be developed and implemented as soon as possible.

The following repair items should be accomplished as part of the general maintenance of the dam:

- 1) Remove all trees and brush growing on the embankment by cutting them off at ground level. Trees with a trunk diameter greater than 3 inches should also have their root systems removed and the resultant holes backfilled, compacted, regraded, and seeded.
- 2) Backfill, compact, and seed the depression on the crest and all areas of erosion.
- 3) Remove the debris lodged in the principal spillway and install a trash rack.
- 4) Repair the leak in the principal spillway riser and monitor for future leakage.
- 5) Extend the outlet pipe, fill, compact, and seed the eroded area. The length to which the pipe and embankment must be extended should be determined as part of the stability analysis of the dam. Provide erosion protection for the channel downstream from the outlet pipe.
- 6) Provide erosion protection for the upstream face of the embankment.
- 7) Clear the downstream channel of debris, trees, and brush.
- 8) Install a staff gage to monitor reservoir levels above normal pool.

NAME OF DAM: WARRENTON LAKE DAM

APPENDIX

PLATE

## CONTENTS

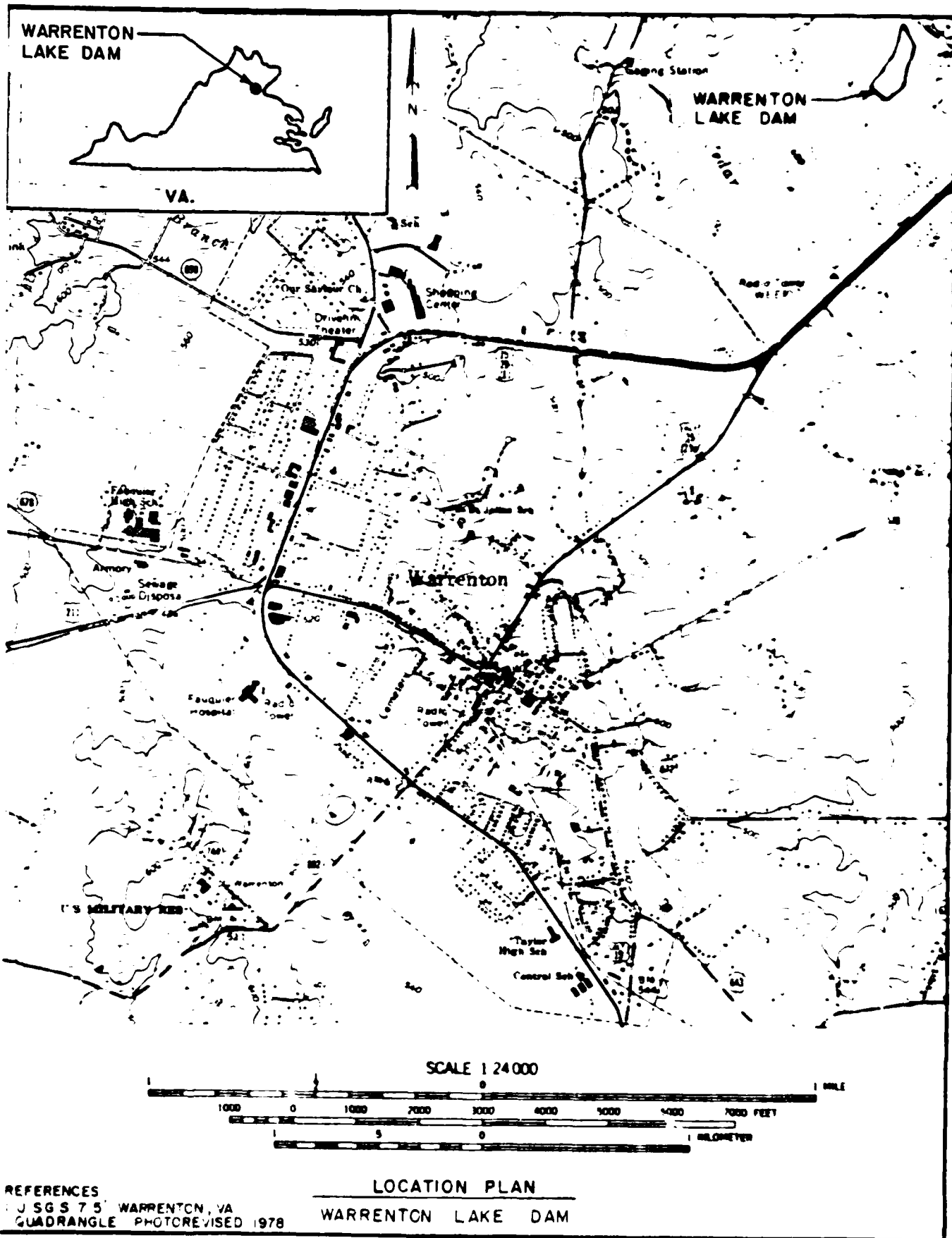
Location Plan

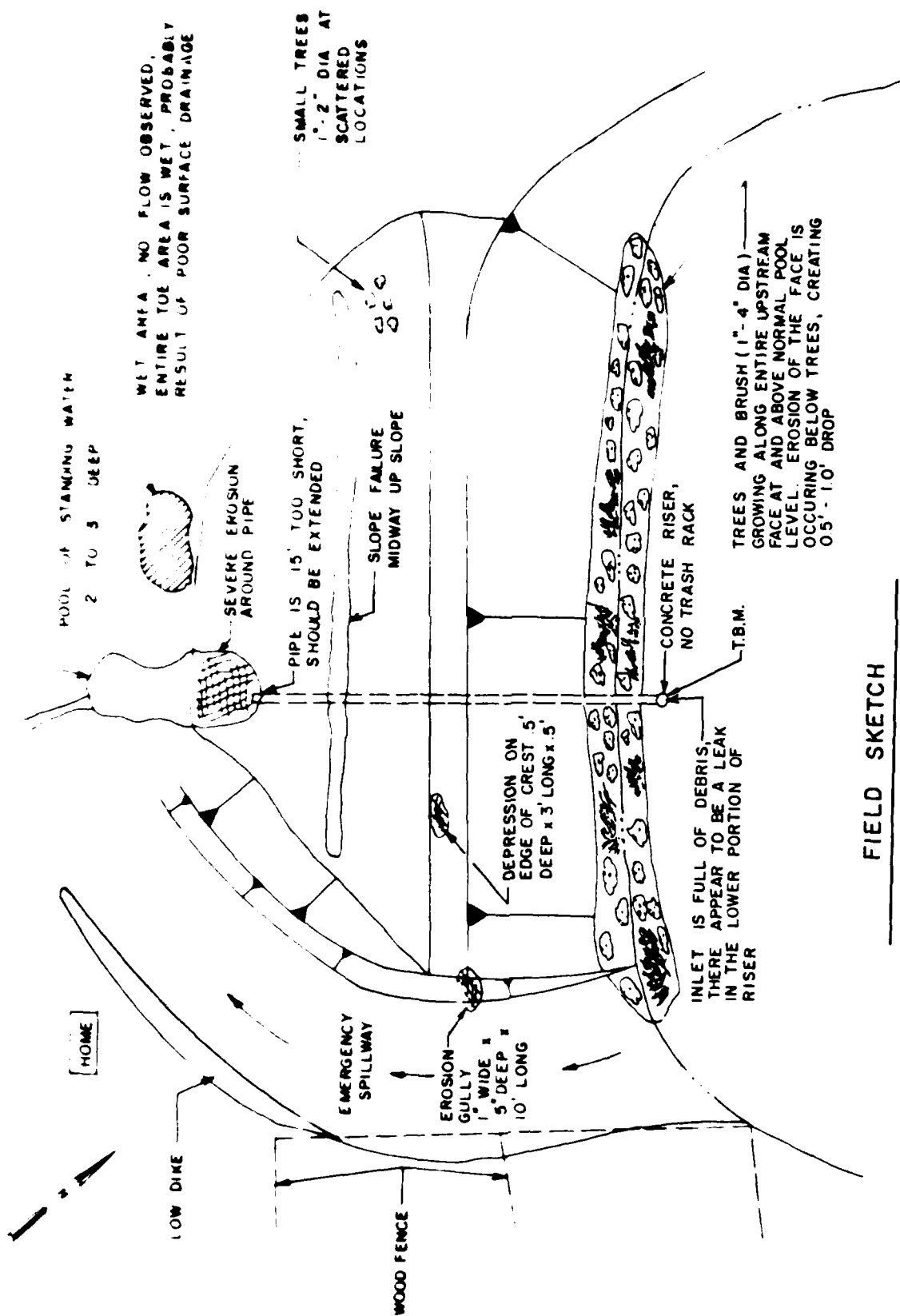
Plate 1: Field Sketch

Plate 2: Top of Dam Profile

Plate 3: Typical Cross Sections

NAME OF DAM: WARRENTON LAKE DAM





FIELD SKETCH  
WARRENTON LAKE DAM  
20 MAY 1981

NO SCALE

MICHAEL BAKER JR. INC.  
THE BAKER ENGINEERS

Box 280  
Houston, Texas 77002

Subject: *1224-1-2-1*

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APPENDIX II

PHOTOGRAPHS



## CONTENTS

- Photo 1: Downstream Face of Embankment
- Photo 2: Upstream Face of Embankment
- Photo 3: Riser Crest
- Photo 4: Eroded Area Around Outlet Pipe
- Photo 5: Emergency Spillway
- Photo 6: Typical Area of Slope Failure on Downstream Face  
of Embankment

Note: Photographs were taken on 20 May 1981.

NAME OF DAM: WARRENTON LAKE DAM

# **WARRENTON LAKE DAM**



**PHOTO 1. Downstream Face of Embankment**



**PHOTO 2. Upstream Face of Embankment**

**WARRENTON LAKE DAM**



**PHOTO 3. Riser Crest**

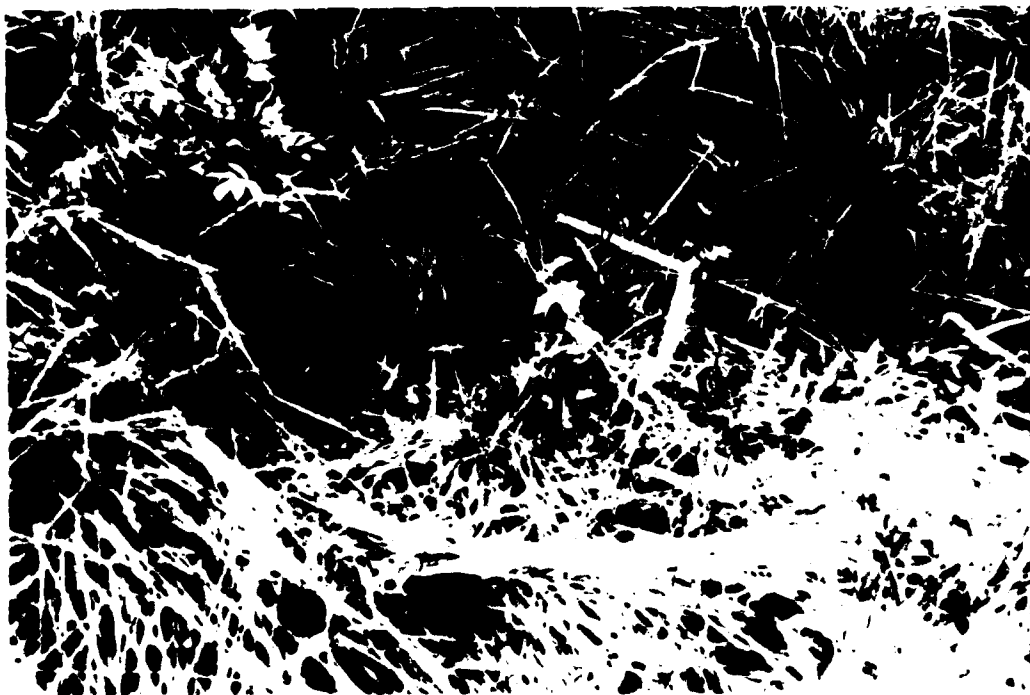


**PHOTO 4. Eroded Area Around Outlet Pipe**

# **WARRENTON LAKE DAM**



**PHOTO 5. Emergency Spillway**



**PHOTO 6. Typical Area of Slope Failure on Downstream Face  
of Embankment**

APPENDIX III  
VISUAL INSPECTION CHECK LIST

Check List  
Visual Inspection  
Phase I

Name of Dam Warrenton Lake County Fauquier State Virginia Coordinates Lat. 3841.1

Long. 7744.8

Date of Inspection 20 May 1981 Weather Clear Temperature 65°F.

Pool Elevation at Time of Inspection 999.8 T.B.M. Tailwater at Time of Inspection 983.1 T.P.M.

Inspection Personnel:

Michael Baker, Jr., Inc.

Wayne D. Lasch  
Steve M. Lockington  
Dave W. Miller

Owner's Representatives:

Home Owners' Association  
Representatives

Becky Crouch  
Audrey Graham  
Don Philp

Virginia State Water Control Board

Hugh Gildea  
Recorder

Wayne D. Lasch

# EMBANKMENT

Name of Dam WARRENTON LAKE DAM

VISUAL EXAMINATION OF OBSERVATIONS REMARKS OR RECOMMENDATIONS

SURFACE CRACKS

None were observed.

UNUSUAL MOVEMENT OR  
CRACKING AT OR BEYOND  
THE TOE

None were observed

SLAUGHING OR EROSION OF  
EMBANKMENT AND ABUTMENT  
SLOPES

The upstream face of the embankment is covered with small trees and brush (1-4 in. dia.) at and above normal pool level. Erosion of the face is occurring below these trees, resulting in a vertical drop in the face of 0.2-0.5 ft. Severe erosion is also occurring on the downstream face of the embankment at and above the outlet pipe exit. It appears that the slope of the embankment around the outlet pipe was increased, decreasing the bottom width of the embankment to allow for a shorter length of pipe through the embankment. It is in this steeper portion of the embankment where the severe erosion is taking place. Sloughing and a one ft. scar exist along the length of the downstream slope and indicates a slope failure.

The erosion of the upstream face is not considered to be a serious problem at this time. However, the trees and brush should be removed and another means of erosion protection provided. The embankment at and above the outlet pipe should be repaired. The embankment should be filled in and compacted to, at a minimum, the slope of the surrounding embankment and the outlet pipe extended is necessary. A qualified geotechnical engineer should investigate the slope failure and perform a stability analysis of the

# EMBANKMENT

Name of Dam WARRENTON LAKE DAM

VISUAL EXAMINATION OF OBSERVATIONS REMARKS OR RECOMMENDATIONS

VERTICAL AND HORIZONTAL  
ALIGNMENT OF THE CREST

There is a small depression on the downstream edge of the embankment crest between the outlet works and the emergency spillway. No other problems were observed.

Fill in the depression.

RIPRAP FAILURES

This is not applicable.



# EMBRANKMENT

Name of Dam: WATER LOCK DAM

## VISUAL EXAMINATION OF

JUNCTION OF EMBANKMENT  
AND ABUTMENT, SPILLWAY  
AND DAM

## OBSERVATIONS:

At or near the junction of the dam and the spillway, there were no visible signs of seepage, erosion, or other problems were observed.

## REMARKS OR RECOMMENDATIONS

The gully should be filled, compacted, and reseeded.

## ANY NOTICEABLE SEEPAGE

A wet area was observed along the toe of the dam to the right of the outlet pipe. There was no measurable flow from the area. No other problems were observed.

This wet area is probably the result of poor surface drainage. The area should be regraded to improve drainage and monitored for seepage.

## STAFF GAGE AND RECORDER

There were none.

A staff gauge should be installed to monitor pool levels above normal pool.

## DRAINS

There were none.

# OUTLET WORKS

Name of Dam: WARRENTON LAKE DAM

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	None were observed.	
INTAKE STRUCTURE	The intake consists of a 48-in. dia. concrete riser pipe. There is no trash rack protecting the pipe, and there is debris in the bottom of the pipe. There also appears to be a leak in the lower section of the riser.	The debris should be removed from the pipe and a trash rack installed. The leak in the pipe should be sealed.
OUTLET PIPE	The outlet pipe is an 18-in. dia. concrete pipe. As discussed in previous sections, the pipe is not long enough.	The pipe should be extended a minimum of 15 ft.
CHANNEL	The outlet channel is a natural channel. It is approximately 10 ft wide and 2 ft deep. It is located about 100 ft from the pipe. The channel is not straight and has several bends. The debris in the channel backs up to the pipe.	The debris should be removed and the channel graded to improve flow out of the channel.

# UPDATED SPILLWAY

EXAMINATION OF F

WAS IN CONCRETE WELL.

DATE 3-1-1966

the reservoir slopes gently up to the entrance of the emergency spillway the spillway is a trapezoidal earth channel. There is a good cover of grass in the channel. Resident near the dam indicated that, during a storm approximately 5 years ago, the emergency spillway was activated. A gully was cut in the channel approximately 5 ft. deep. A sewer pipe was reportedly laid in this gully when it was repaired 1 year later. The channel is protected now by wooden fences surrounding the footings on either side of the left abutment.

The fences infringing on the channel should be removed.

DATE 3-1-1966

The main channel is a trapezoidal earth channel consisting of heavy soil with a surface cover of grass. A like with a base of 4 ft. below the right abutment. The right side of the channel is bordered by a fence of steel posts and wire mesh. There is a fence on the left side of the channel. The fence is made of wooden posts and wire mesh. The fence is made of wooden posts and wire mesh.

DATE 3-1-1966

# INSTRUMENTATION

Name of User: WARENING, JAY DAP

## FIELD EXAMINATION

## OBSERVATIONS

## RESULTS OF RECONSTRUCTIONS

### RECONSTRUCTION/SURVEYS

None were observed

### OBSERVATION WELLS

None were observed

### WELLS

None were observed

### PIEZOMETERS

None were observed

### OTHER

# RESERVOIR

Name of Dam: WARRENTON LAKE DAM

## REMARKS OR RECOMMENDATIONS:

### OBSERVATIONS

#### SLOPES

The slopes of the reservoir are moderate to mild with no signs of erosion or instability. They were grass covered with a number of residences surrounding the reservoir.

#### SEDIMENTATION

Sedimentation does not appear to be a problem. Soundings were taken, and the depth of the normal pool was measured to be 13.4 ft. near the riser pipe.

# DOWNSTREAM CHANNEL

Name of Dam: WARRENTON LAKE DAM

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
-----------------------	--------------	----------------------------

## CONDITION

(OBSTRUCTIONS,  
DEBRIS, ETC.)

A road into the housing development crosses the downstream channel 560 ft. downstream, and another dam is 1900 ft. downstream from the dam.

## SLOPES

The channel has moderate slopes.

## APPROXIMATE NO. OF HOMES AND POPULATION

Two homes are located in the flood plain between the road and the downstream dam.

APPENDIX IV  
GENERAL REFERENCES

## GENERAL REFERENCES

1. Bureau of Reclamation, U.S. Department of the Interior, Design of Small Dams, A Water Resources Technical Publication, Revised Reprint, 1977.
2. Chow, Ven Te, Handbook of Applied Hydrology, McGraw - Hill Book Company, New York, 1964.
3. Chow, Ven Te, Open Channel Hydraulics, McGraw - Hill Book Company, New York, First Edition, 1959.
4. Commonwealth of Virginia, "Geologic Map of Virginia," Department of Conservation and Economic Development, and Division of Mineral Resources, 1963.
5. HR 33, "Seasonal Variations of Probable Maximum Precipitation, East of the 105th Meridian for Areas 10 to 1000 Square Miles and Durations of 6 to 48 Hours," (1956).
6. King, Horace Williams and Brater, Ernest F., Handbook of Hydraulics, Fifth Edition, McGraw - Hill Book Company, New York, 1963.
7. Soil Conservation Service, "National Engineering Handbook - Section 4, Hydrology," U.S. Department of Agriculture, 1964.
8. Soil Conservation Service, "National Engineering Handbook - Section 5, Hydraulics," U.S. Department of Agriculture.
9. U.S. Army, Hydrologic Engineering Center, "Flood Hydrograph Package (HEC-1), Dam Safety Investigations, Users Manual," Corps of Engineers, Davis, California, September 1978.
10. U.S. Army, Hydrologic Engineering Center, "HEC-2 Water Surface Profiles, Users Manual," Corps of Engineers, Davis, California, October 1973.
11. U.S. Army, "Inventory of United States Dams," Corps of Engineers, 9 September 1978.
12. U.S. Army, Office of the Chief of Engineers, "Appendix D, Recommended Guidelines for Safety Inspection of Dams," National Program of Inspection of Dams, Volume 1, Corps of Engineers, Washington, D.C., May 1975.

NAME OF DAM: WARRENTON LAKE DAM



13. U.S. Army, Office of the Chief of Engineers, Engineering Circular EC-1110-2-163 (Draft Engineering Manual), "Spillway and Freeboard Requirements for Dams, Appendix C Hydrometeorological Criteria and Hyetograph Estimates," (August 1975).
14. U.S. Army, Office of the Chief of Engineers, Engineering Circular EC-1110-2-188, "Engineering and Design, National Program of Inspection of Non-Federal Dams," Corps of Engineers, Washington, D.C., 30 December 1977.
15. U.S. Army, Office of the Chief of Engineers, Engineer Technical Letter No. ETL 1110-2-234, "Engineering and Design, National Program of Inspection of Non-Federal Dams, Review of Spillway Adequacy," Corps of Engineers, Washington, D.C., 10 May 1978.
16. U.S. Department of Commerce, "Technical Paper No. 40, Rainfall Frequency Atlas of the United States for Durations from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years," Weather Bureau, Washington, D.C., May 1961.
17. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, "Hydrometeorological Report No. 51, Probable Maximum Precipitation Estimates, United States East of the 105th Meridian," Washington, D.C., June 1978.

NAME OF DAM    WARRENTON LAKE DAM

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